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# Chapter 5
# Reduced self-control after three months of imprisonment

**Jesse Meijers, Joke M. Harte, Gerben Meynen, Pim Cuijpers & Erik J. A. Scherder**

*Submitted*

# ABSTRACT

## Background

Prison can be characterized as an impoverished environment encouraging a sedentary lifestyle with limited autonomy and social interaction, which may negatively affect self-control and executive function. Here, we aim to study the effects of imprisonment on self-control and executive functions, and we report the change in neuropsychological outcome after three months of imprisonment.

## Methods

Participants were 37 male inmates in a remand prison in Amsterdam, the Netherlands, who completed six tests of a computerized neuropsychological test battery (the CANTAB) in the first week of arrival. Participants were retested after three months of imprisonment. Change in performance was tested using the Wilcoxon Signed-Rank test.

## Results

After three months of imprisonment, self-control and attention significantly deteriorated, with large to medium effect sizes. In contrast, planning significantly improved with a medium effect size.

## Conclusions

Our study suggests that three months of imprisonment in an impoverished environment may lead to reduced self-control. This is a significant and societally relevant finding, as released prisoners may be less capable of living a lawful life than they were prior to their imprisonment of, and may be more prone to impulsive risk-taking behaviour. In other words, the impoverished environment may contribute to an enhanced risk of reoffending.

# INTRODUCTION

Currently, more than 11 million people are imprisoned worldwide, and this number continues to rise.[1] Imprisonment is characterised by a sedentary lifestyle.[2-6] For example, many prisoners do not meet the generally accepted norm of 30 minutes of moderate physical activity per day, and one study in particular found that UK prisoners tend to sit or lie on their beds for more than 9 hours per day.[4] Imprisonment also inherently results in decreased autonomy – as many responsibilities and decisions are shifted to the prison staff[7] – and in social isolation, as prisoners are largely isolated from their own social networks.

Due to the sedentary lifestyle, social isolation, and a lack of cognitive challenges, prison can be considered an impoverished environment, which may negatively affect executive functions and prefrontal functioning of the brain.[8, 9] Executive functions are top-down cognitive functions crucial for self-control,[10] such as planning, attention, working memory, set-shifting and inhibition, largely regulated by the prefrontal cortex of the brain.[11] The prefrontal cortex is also important for bottom-up self-control: by enhancing activity in subcortical areas that favour an appropriate response, subcortical areas favouring inappropriate or impulsive responses are subsequently (thus indirectly) inhibited.[10] Besides the potential negative influence of the impoverished environment on self-control and prefrontal functioning, indirect consequences of an impoverished environment, such as chronic stress and sleep disturbances, from which prisoners often suffer,[4, 12-14] may also negatively influence prefrontal functioning. Sleep disturbances are also considered to be a risk factor for aggressive behaviour, especially in a high-risk population.[15]

Reduced prefrontal structure and functioning, impaired executive functions, as well as impulsivity (the result of a failure in bottom-up self-control), are hallmark features of antisocial and criminal populations.[16, 17] Though prospective studies are lacking, some studies show a relationship between executive or prefrontal dysfunction and increased reoffending.[18, 19] The question arises whether imprisonment in an impoverished environment may lead to a decline – or a further decline – in prefrontal functioning and self-control, which, in turn, may lead to increased risk of criminal recidivism.

In the current study, we investigate whether imprisonment reduces executive functions and self-control. To our knowledge, this is the first prospective study to address this question. We focused on change in impulsive risk taking (bottom-up self-control) and executive function (top-down self-control) in remand prisoners after three months of imprisonment, and hypothesize an overall decline in executive functions and self-control.

# METHOD

## Participants

Participants were recruited between 2013 and 2015 at the Penitentiary Institution Amsterdam Over-Amstel – a remand prison in Amsterdam, The Netherlands. We tested 130 male remand prisoners in their first week of imprisonment (T1), a comprehensive description of this population has been given elsewhere.[20] After three months (T2), we retested 37 of the participants (mean age = 30.5, SD = 9.9). Characteristics of this retested sample can be found in the results section (Table 1). We elaborate on our choice to retest participants after three months and on the dropout rate in the Results, as well as in the limitations section of the Discussion.

## Materials

Six tests of the CANTAB (Cambridge Automated Neuropsychological Test Battery, Cambridge Cognition, Cambridge, UK) were used to assess executive functions. Interactive demos and extensive descriptions of these tests are available at manufacturer website (www.cambridgecognition.com). The tests were administered on a Windows 7, 12.1" by CANTAB recommended touchscreen tablet, with a screen resolution of 1280*800. The reported test-retest correlations for the subtests are 0.6 – 0.9.[21, 22] The following six subtests were used and administered – in the order described below – for all participants, at baseline (T1) and after three months (T2).

Stockings of Cambridge (SOC), analogue to the commonly used Tower of London, measures planning. Presented with a horizontally split screen, participants are instructed to copy the pattern of coloured balls in the upper half, by moving the coloured balls in the lower half. Difficulty increases from 2 to 5 moves that are minimally needed. The main outcome variable is the *number of problems solved in the minimum required moves*.

The Spatial Working Memory task (SWM) measures working memory. When presented with multiple closed coloured square boxes, participants are instructed to search for a small blue square hidden within one of the closed boxes. The closed boxes will contain a blue square only once; participants therefore have to remember in which box they already found a blue square, and in which they did not. Looking inside a closed box that already contained a blue square once, is classified as a *between error*. Looking inside a closed square twice within the same search is classified as a *within error*. The main outcome variable is *total errors (adjusted)*.

The Stop Signal Task (SST) is a classic stop signal response inhibition test that measures response inhibition. This task uses a two-button press pad instead of the touch screen. Participants are instructed to press the left or right button as fast as they can, when they are presented with an arrow pointing to the left or right. After an initial practice set, participants are instructed to withhold their response when they hear an auditory signal (a beep). The main outcome variable is the *stop-signal reaction time* (*SSRT*), which is calculated by subtracting the *stop signal delay* (*SSD*) from the *mean reaction time* (*MRT*).

The Intra-Extra Dimensional Set-Shift task (IED) measures set-shifting. Participants are presented with two clearly distinct types of stimuli, i.e. purple coloured shapes and white lines, and learn which stimulus they should choose through feedback. After six correct responses, an intra-dimensional shift occurs, i.e. the correct answer is switched from one purple shape to another purple shape. After a number of intra-dimensional shifts, extra-dimensional shifts start to occur, i.e. the correct answer switches from a purple coloured shape to a white line. The main outcome variable is *total errors (adjusted)*.

The Choice-Reaction Time task (CRT) measures sustained attention. Similar to the first stage of the SST, participants are instructed to press the left or right button as fast as possible, when the corresponding left/right pointing arrow is presented on the screen. The main outcome variables are *mean reaction time*, and *SD reaction time,* indicating the variability in reaction time.

The Cambridge Gambling Task (CGT) measures impulsivity and risk-taking. Under one of ten either red or blue squares that are presented on the top of the screen, a yellow square is hidden by the computer each round. Participants are instructed to make as much profit as possible, by repeatedly betting a proportion of their points on one of the two possible outcomes (red or blue). The main outcome variables are *overall proportion bet* and *delay aversion*.

Intelligence was estimated using two subtests, Information and Block Design, of the Wechsler Adult Intelligence Scale - fourth edition (WAIS-IV). This short form highly correlates ($r$ = .931) with full scale IQ.[23]

The most common DSM-IV axis I diagnoses, as well as antisocial personality disorder and addiction, were screened for using the MINI International Neuropsychiatric Interview 5.0.0 – a short, structured diagnostic interview.[24, 25]

Self-reported general mental and physical symptoms, such as pain, depression and hopelessness, were assessed using the Symptom-Checklist-90.[26] Test-retest correlations for the SCL-90 range from r = .68 to .80.[27]

## Procedure

We collected basic demographic data and information, such as criminal history, from the prison's administrative databases. On a weekly basis, newly detained eligible prisoners were approached. Suspects of more serious crimes (e.g. murder, arson, rape or aggravated assault) were prioritized in order to account for their lower prevalence compared to less serious, non-violent crimes (e.g. shoplifting). Prisoners were excluded if their stay was of transient nature, e.g. when they were awaiting extradition, when they were scheduled to be transferred to a different facility or scheduled for deportation to their home country. In a few exceptional cases, the prison staff did not allow us to approach specific prisoners, due to safety concerns. Further exclusion criteria included active psychosis, insufficient understanding of the Dutch or English language, visual or motor impairments to such a degree that tests cannot be seen or executed properly, insufficient understanding of the goal of the study or conditions concerning participation, and aggressive or inappropriate behaviour towards the researcher. All approached prisoners were verbally invited to consider participating in our study. They were informed about the study's goal and conditions, the tests that were used and the estimated time it would consume. A more extensive information letter was handed out to those interested, which could be read after this short introduction. An appointment was scheduled for the test administration with the prisoners who were willing to participate. We emphasized their right to cancel that appointment and to withdraw from the study at any given time without any consequences. We estimate the recruitment success percentage to be around 60%.

The current paper is part of a larger study encompassing a number of measures that are not used in the current paper, i.e. heart rate, measured with the VU-AMS, and physical activity, measured with the IPAQ and Actical. The following section describes the procedure for the measures used in the current paper.

Testing took place within 7 days after the participants' arrival in the Penitentiary Institution. T1 consisted of two separate appointments. Each first appointment started with the opportunity for the participant to ask questions about the study and the information letter. Next, the informed consent form was explained, and signed by both the participant and the researcher. We collected data on medication history and current use, history with drug abuse, education level, history with traumatic brain injury and other relevant medical history during anamnesis. We also inquired about recent drug use within the institution. After they were informed about the confidentiality, a small number of participants reported recent drug use, which led to rescheduling or cancelling of the appointment.

After anamnesis, we administered the CANTAB tests, with an average duration of an hour, and asked the participants to fill in the SCL-90 at their own convenience. The second T1-appointment was planned within 21 days of arrival at the Penitentiary Institution, rather than 7 days, as IQ and psychiatric diagnoses are relatively stable in nature and thus less sensitive to the hypothesized negative influence of the prison environment. At this second T1-appointment, we administered the two WAIS subtests and the MINI, and answered questions that participants may have had about the SCL-90. At the end of the second appointment, participants were informed that we would approach them after approximately three months – if they were still imprisoned at the Penitentiary Institution of Amsterdam Over-Amstel at that time – to inquire whether they were still prepared to be retested. After three months (T2), participants were retested according to the procedure of the first appointment at T1.

Written informed consent was obtained from all participants. The study received ethical approval from the Ethics Committee for Legal and Criminological Research of the faculty of Law, Vrije Universiteit Amsterdam and a statement of the accredited medical ethical committee of the Vrije Universiteit Medical Centre that the study requires no further ethical approval. This study has been registered in the Dutch Trial Register (NTR5443, www.trialregister.nl). Prisoners did not receive an incentive for participation, as the Custodial Institutions Agency did not allow us to do so. However, spending more time outside the prison cell is often considered as an incentive in itself, regardless of the activity. The safety of the participants and the researchers was guaranteed by the Penitentiary Institution. Data were stored according to the regulations for scientific research of the Custodial Institutions Agency (Dutch acronym: DJI) and will be saved for 15 years.

### Statistical analyses

SPSS version 23 was used to analyse the data. We used ANOVA to analyse whether the participants that were tested at T2 differed – at T1 – from the participants not tested at T2, on any of the neuropsychological outcome measures and other relevant variables, such as demographics and type of crime. Change in performance between T1 and T2 was tested using the robust, non-parametric Wilcoxon Signed-Rank test – because of a non-normal distribution for most of the variables and the presence of a number of outliers – using $P < .01$ as the level of significance to correct for multiple testing.

In G*Power,[28] with alpha = .05, power = .80 and effect size = .50, sample size calculation for the matched pairs Wilcoxon Signed-Rank test (T1 – T2) resulted in N = 35 to achieve sufficient power.

### Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

## RESULTS

As many of the participants who had been tested at baseline were released before reaching three months of imprisonment, a significant number of participants were not retested at T2. Besides a higher proportion of violent offenders, the group of participants that we retested at T2 did not differ from the group that we only tested at T1 on any of the neuropsychological outcome measures at baseline or other relevant demographic variables ($P > .072$). Characteristics of the retested participants can be found in Table 1.

To investigate the effect of imprisonment on EF, we analysed change in performance (T1 – T2) on six subtests of the neuropsychological test battery. Risk taking (CGT Overall Proportion Bet) significantly increased after three months of imprisonment with a large effect size, N = 29, $T = 11$, $P < .001$, $r = .49$. Attentional performance (CRT SD: variability in reaction time on a sustained attention task) significantly decreased at T2 with a medium effect size, N = 35, $T = 16.95$, $P = .005$, $r = .33$. In contrast, planning (SOC Problems solved in minimum moves) significantly improved with a medium effect size, N = 37, $T = 11.71$, $P = .006$, $r = .34$. No further significant changes were found, see Table 2 for an overview of the outcome measures at T1 and T2.

## Table 1. Study sample characteristics (N = 37)

| Characteristic | M (SD) or No. (%) |
| --- | --- |
| Age | 30.54 (9.9) |
| Education level[a] | 4.73 (1.1) |
| Estimated IQ[b] | 89.31 (18.8) |
| No. of previous detentions | 3.86 (4.7) |
| No. of days spent imprisoned during previous detentions | 334 (418) |
| Violent offenders | 20/37 (54%) |
| Estimated hours per day spent in bed during daytime[c] | 6.54 (4.2) |

[a] Education level according to Verhage, a commonly used scale in the Netherlands ranging from 1 to 7
[b] Estimated using Block Design and Information of the WAIS-IV
[c] Self-reported estimate of the participants at T2

## Table 2. Results on the CANTAB outcome measures on T1 and T2

| | T1 | T2 | | | |
| --- | --- | --- | --- | --- | --- |
| CANTAB Outcome measures | M (SD) | M (SD) | N | *P Value* | *r* |
| SOC Problems solved in min. moves | 7.81 (1.63) | 8.92 (1.89) | 37 | **.002** | **.34** |
| SWM Total Errors | 16.24 (9.91) | 13.84 (11.99) | 37 | .047 | .23 |
| SST SSRT | 190.66 (59.46) | 171.08 (54.83) | 36 | .157 | .17 |
| IED Stages Completed | 7.86 (1.87) | 8.03 (1.92) | 36 | .496 | .08 |
| CRT Mean Correct Latency | 309.63 (51.39) | 316.79 (64.02) | 35 | .704 | .04 |
| CRT SD Correct Latency | 72.03 (38.29) | 84.62 (48.32) | 35 | **.005** | **.33** |
| CGT Delay Aversion | .291 (.166) | .235 (.176) | 29 | .132 | .20 |
| CGT Overall Proportion Bet | .507 (.151) | .605 (.133) | 29 | **< .001** | **.49** |

SOC: Stockings of Cambridge (planning); SWM: Spatial Working Memory; SST SSRT: Stop Signal Task Stop Signal Reaction Time (response inhibition); IED: Intra-Extra Dimensional Set-Shift Task (Set-shifting); CRT: Choice Reaction Time (attention); CGT: Cambridge Gambling Task (risk taking behaviour / self-control)

# DISCUSSION

The purpose of this study was to investigate the influence of imprisonment on executive functions and self-control. In line with our hypothesis of a decline in executive functions during incarceration, our results show a significant deterioration in self-control and attention after three months of imprisonment. Additionally, we observed an increased performance on a planning-task, which is in contrast with our hypothesis. Yet, it is noteworthy that improvements on neuropsychological tasks are often caused by practice effects.[29] A control group would be needed to determine whether the increased performance in our sample is over and beyond such practice effects. Therefore, though participants may show improvements in planning, we emphasize the decline found in self-control and attention, as these are opposite to the expected improvements due to aforementioned practice effects.

The decrease in self-control was reflected on the Cambridge Gambling Task, measuring bottom-up self-control, while performance on the Stop Signal Task, measuring top-down response inhibition, remained constant. This finding suggests that the prison environment may impair bottom-up self-control specifically, while top-down response inhibition remains unaffected. Impaired bottom-up self-control may lead to impulsive risk taking in the face of reward: due to lowered prefrontal activity, a potential reward may be overestimated, while the potential negative consequences are underestimated. Although we found reduced response inhibition in violent offenders compared to non-violent offenders in our previous study,[20] one could argue that reduced bottom-up self-control may also exacerbate the risk for aggressive or violent behaviour in high-risk individuals, as self-regulation is a complex interplay between both top-down and bottom-up inhibition.[10]

Although remarkably little is known about the effects of imprisonment on brain function and executive functions, as well as on the influence of imprisonment on reoffending and its possible underlying mechanisms,[30] recent studies do suggest that harsher – thus more impoverished – prison conditions may increase the risk of reoffending.[31, 32] Within the prison environment, limited autonomy, provocations and temptations result in a reduced demand on a person's self-control, or functions regulated by the prefrontal cortex, when compared to life outside of the prison walls. However, a successful return to society requires autonomous goal-directed behaviour and self-control, as released prisoners are expected to refrain from further criminal behaviour, and instead attain housing and a legitimate income. In fact, the impoverished prison environment may negatively affect executive functions needed for a successful return to society.

Even though we tested 130 prisoners at baseline, only 37 remained available willing to be retested at T2. However, when conducting such a study in a remand prison, researchers should always take into consideration that many of their participants will remain imprisoned for a limited amount of time. In fact, in the Netherlands, remand prisoners are detained for 103 days on average – which is why we chose to retest after three months – and 55% is released within one month of imprisonment. To avoid a negative influence of the prison environment prior to testing, we deliberately chose to conduct our study in a remand prison among newly detained inmates. Future studies could consider focusing on convicted offenders that have awaited their trials at home. This would most probably reduce dropout significantly – since a suitable moment for T2 could be determined for each participant individually – and would also avoid the potential negative influence of imprisonment prior to testing. The question arises, however, how large the sample size would become when focusing on this very specific subgroup of offenders. Either way, the current study was a relatively small and explorative study that should be replicated in a larger sample and include a non-imprisoned control group. Future researchers should bear in mind that collecting data in a prison setting is rather time-consuming compared to most other settings.[33]

In sum, the decline in self-control which we observed in prisoners is a significant and societally relevant finding, possibly also regarding criminal recidivism. Released prisoners may be less capable than they were before imprisonment to live a lawful life outside of crime and may be more prone to impulsive risk-taking behaviour. This finding may also partly explain why several studies report a relationship between harsher prison environments and higher reoffending rates.[30-32] Our results call for further research regarding the impact of the prison environment on brain function and self-control, as well as the influence of the prison environment on reoffending. Ultimately, this may lead to the recommendation that prisons be transformed into enriched environments to increase, or at least preserve, prisoners' self-control.

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